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Flowers and Insects. III.

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Nelumbo[1] *lutea* Planch.—The flowers are female in the first stage. On the first day the petals separate at tips, so that insects can enter and crawl about upon the carpophore and over the stigmas. At this time the anthers are indehiscent and are pressed close against the sides of the carpophore, being held in this position by the erect petals. The claw-like tips of the anthers, the only parts of the stamens now visible, form a close circle between the petals and the edge of the carpophore, thus opposing insects which might attempt to reach the pollen.

On the second day, when the petals begin to separate, insects can only reach the anthers, which are now discharging pollen, by crawling over the stigmas. Later, when the petals become widely expanded and the anthers fall upon them, insects no longer light upon the carpophore.

Delpino regards flowers of this genus as specially adapted to beetles which he supposes visit the flowers to gnaw the carpophore. I have never seen them eating this part, nor are they sufficiently abundant on the flowers to be of much use. Moreover, they remain almost stationary and seldom fly from flower to flower. Delpino has classed the flowers of Nymphæaceæ in general as *cantharophilous*, it seems to me without enough evidence. I have found Nymphæa[1] and Nelumbo visited only for pollen and Nuphar[2] both for pollen and nectar. The principal visitors are Andrenidæ, especially species of Halictus, and Syrphidæ.

Visitors (observed on 3 days between July 26 and August 12): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ☿, c. p., ab.; (2) *Ceratina dupla* Say ♀. *Andrenidæ:* (3) *Agapostemon radiatus* Say ♀, ab.; (4) *Augochlora pura* Say ♀, ab.; (5, 6) Halictus spp. ♀, ab.; (7) *H. ligatus* Say ♀; (8) *H. Lerouxii* St. Farg. ♀ (= *parallelus* Sm.); (9) *H. parallelus* Say ♀, ab. (= *occidentalis* Cr.); (10) *H. pilosus* Sm. ♀, ab.; (11) *H. confusus* Sm. ♀, ab., all c. p.; (12) Prosopis

[1] On the fertilization of Nelumbo see Delpino: Ulteriori osservazioni sulla dicogamia nel regno vegetale: and Comes: Studii sulla impollinagione in alcune piante.

[2] BOT. GAZETTE, XIV, 122-125.

sp. ♀ ; (13) *P. affinis* Sm. ♀, both f. p. *Scoliidæ:* (14) *Myzine interrupta* Say ; (15) *Scolia bicincta* F.

Diptera—*Syrphidæ:* (16) *Pipiza pullchella* Will. ab. ; (17) *Chrysogaster nitida* Wied. ; (18) *Syrphus ribesii* L. ; (19) *Mesograpta marginata* Say ; (20) *Sphœrophoria cylindrica* Say ; (21) *Syritta pipiens* L., all f. p. *Ephydridæ:* (22) *Notiphila unicolor* Lw., f. p.

Coleoptera—*Coccinellidæ:* (23) *Megilla maculata* De G. ; (24) *Hippodamea 13-punctata* L. *Cerambycidæ.* (25) *Leptura plebeja* Rand. *Chrysomelidæ:* (26) *Diabrotica 12-punctata* F., ab., all f. p.

Workers of Bombus separatus, B. americanorum[3] and B. scutellaris dropped into the flowers, but immediately flew away, as if they had failed to find what they sought. I also found Bombus virginicus, Agapostemon radiatus and Lucilia cornicina dead in the flowers, where they had probably been enclosed by the petals and suffocated by the heavy odor.[4]

Dentaria laciniata Muhl.—This flower agrees in most respects with Cardamine pratensis, as described by Müller. But the nectaries which occupy the position of the two missing stamens are of nearly or quite the same importance as those surrounding the bases of the two short stamens. Accordingly the saccate bases of the sepals which hold the nectar from these glands are of about the same size as the others. The stigma commonly surpasses the anthers, so that it strikes the bee in advance of them, but there is a chance of self-pollination in absence of insects.

The erect sepals and the claws of the petals measure about 8 mm., and with the stamens and style narrow all ways of access to the nectar, so that only insects with a tongue 8 mm., or longer, can reach the nectar with perfect ease. But short-tongued bees sometimes manage to force their way in so as to reach the sweets. The flowers are white, or sometimes with a purplish tinge, and grow in rather conspicuous umbels. There are more long-tongued bees than in Müller's list of visitors of C. pratensis.

Visitors (observed on 7 days, between April 2 and 20):

[3] *Bombus americanorum* Fabr. is our common bumble bee. For a long time it has been mixed up with *B. pennsylvanicus* De Geer, but it is a distinct species, and *B. elatus* Fabr. (Apathus? elatus) is its male. I have taken the sexes of B. pennsylvanicus in copula. I have also taken B. elatus in copula with B. americanorum. Three nests of the latter which I opened contained no male bees except B. elatus. The nest mentioned in Proc. Ent. Soc. Phil., II, 164, said to contain 6 females and 34 workers of B. pennsylvanicus and 21 males of Apathus elatus, must have belonged to B. americanorum.

[4] Delpino mentions that insects are so killed in flowers of N. speciosa.

Hymenoptera—*Apidæ:* (1) *Apis mellifica* L., s. and c. p.; (2) *Bombus separatus* Cr. ♀, s.; (3) *B. virginicus* Oliv. ♀, s; (4) *B. americanorum* F. ♀, s.; (5) *Synhalonia honesta* Cr. ♂♀, s.; (6) *Ceratina dupla* Say ♂ s.; (7) *Osmia lignaria* Say ♂, s.; (8) Nomada sp. ♀, s. *Andrenidæ:* (9–11) Andrena spp. ♂♀, s.; (12) Halictus sp. ♀, s.; (13) *H. confusus* Sm. ♀, s.; (14) *H. stultus* Cr. ♀, c. p.

Diptera—*Bombylidæ:* (15) *Bombylius fratellus* Wied. s. *Syrphidæ:* (16) *Syrphus ribesii* F.; (17) *Sphærophoria cylindrica* Say, both f. p.

Lepidoptera—*Rhopalocera:* (18) *Lycæna comyntas* Godt.; (19) *Papilio ajax* L.

At Madison, Wis., in May, Prof. Trelease found it visited by Ceratina dupla, Osmia albiventris, ♂, and Pieris rapæ.

Geranium maculatum L.[5]—The flower agrees with the larger flowered species (G. palustre and pratense) described by Müller. The five outer stamens discharge their pollen over the center of the flower, and afterwards the five inner do the same. The anthers commonly fall off before the stigma is receptive, and the power of self-fertilization is lost. I have observed that the flowers change slowly in bad weather; some of them are in the male stage for three days and others in the female stage for as long. But on warm fair days they go through both stages on the same day.

Some small insects light upon the petals and are able to reach the nectar, though they are of doubtful value, since they are by no means certain to touch the anthers and stigmas. Müller found species of Halictus especially numerous on G. palustre, and I have found several species of Andrenidæ on this plant; but the larger bees seem to be more useful.

Visitors (observed on seven days between May 1 and 21): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ♀; (2) *Bombus vagans* Sm. ♀; (3) *B. americanorum* F. ♀; (4) *Synhalonia speciosa* Cr. ♀; (5) *Ceratina dupla* Say ♀; (6) *Osmia montana* Cr. ♂. *Andrenidæ:* (7–9) Andrena spp. ♂♀, s. and c. p.; (10) *Augochlora pura* Say ♀; (11) *Halictus coriaceus* Sm. ♀; (12) *H. pilosus* Sm. ♀; (13) *H. confusus* Sm. ♀.

Diptera—*Empidæ:* (14) *Empis labiata* Lw. *Syrphid :* (15) *Helophilus latifrons* Lw., f. p.

[5] See Macloskie: Bot. Gaz., IX, 157. For references to literature of pollination of Geraniaceæ see Trelease; North Am. Geraniaceæ, Mem. Bost. Soc. Nat. Hist., IV, 101. For illustration of this species see Goodale: Wild Fls., Pl. III.

Lepidoptera—*Rhopalocera:* (16) *Colias philodice* Godt. *Sphingidæ:* (17) *Hemaris thysbe* F.—all only sucking except 7–9 and 15.

At Madison, Wis., between May 13 and June 1, Prof. Trelease found as visitors: *Nomada bisignata* Say, *N. articulata* Sm., *Augochlora pura* Say, and Andrena sp., all sucking.

Impatiens[6] *fulva* Nutt.—The flowers of this species, and of the next, are male in the first stage as is well known. The anthers sift out a great quantity of pollen when struck by a bee, and the stigma is receptive after the anthers fall. Compared with I. pallida this plant shows three peculiarities which I think favor humming-birds, viz., the red color, the small landing-place, and the longer and narrower posterior sepal. The landing is about 6 mm. long and 15 mm. wide, while in I. pallida it is 12 mm. long and 25 mm. wide and forms a more convenient resting place for bees. However, the form of I. fulva so closely resembles that of I. noli-tangere, which was developed beyond the range of humming-birds, that it can hardly be explained as a result of bird selection. It originally must have had differences which led the birds to prefer it to I. pallida. There is one peculiarity, however, which may have been produced through the influence of birds, and that is the accumulation of red spots on the original ground color. I have elsewhere expressed the view that irregular bird-flowers were originally modified by bees[7] and have been usurped by birds. From its color, and from the fact that humming-birds are the principal visitors, I regard it as a bird-flower, although bees and butterflies also occur as guests.

The posterior sepal is about 22 mm. long, and its spur, which is commonly coiled upon itself, is about 10 mm.

Visitors: Birds—*Trochilidæ:* (1) *Trochilus colubris* L., ab.

Hymenoptera—*Apidæ:* (2) *Apis mellifica* L. ☿, s. and c. p. Snyder's[8] statement that it can not effect crossing is not true in my neighborhood; (3) *Bombus virginicus* Oliv. ☿, s. and c. p.; (4) *B. americanorum* F. ♂ ☿, s.; (5) *Melissodes bimaculata* Say ♀, s.; (6) *Megachile brevis* Say ♀, c. p., hangs under the anthers so as to bring her abdominal scopa in con-

[6] On the literature of the genus see Trelease: l. c., 102.

[7] Bot. Gaz. xiii. 228.

[8] Am. Nat. xiv. 126.

tact with them and only visits flowers in the male stage. *Andrenidæ:* (7) *Augochlora pura* Say ♀, c. p., works out the pollen with her jaws and front feet, not touching stigma; (8) *Halictus confusus* Sm. ♀, c. p., like no. 6.

Lepidoptera—*Rhopalocera:* (9) *Papilio troilus* L. s.

Coleoptera—*Chrysomelidæ:* (10) *Diabrotica 12-punctata* F., gnaws holes in spurred sepal.[9]

Nos. 1–5 and 8 are useful visitors, while the rest are not. Differences in the pollen-collecting habits of Bombus and Megachile are well illustrated in this case. The former receives pollen on the dorsal surface of her thorax and wipes it off with her front legs to place it in her baskets, the latter turns so as to receive it directly in her scopa. Small species of Halictus commonly visit flowers adapted to larger insects to collect pollen directly from the anthers or to glean stray grains which are scattered about the flower. In the latter case they do no harm. The Syrphidæ also often act as gleaners of stray pollen, and only do harm when they eat it directly from the anthers.

Pollen-gathering is illegitimate behavior in this flower, since it leads the bees to pay more attention to the flowers which are in the male stage. When 2 and 3 are after pollen they neglect flowers in the second stage, since they instantly perceive that the anthers have fallen. The humming-bird coming only for nectar, and being the most rapid flier, is by far the most useful visitor, and it is but natural that it should have most influence in modifying the flower.

Impatiens pallida Nutt.—The flower is "pale-yellow, sparingly dotted with brownish red." It is much larger than in I. fulva, and has a shorter (13 mm.) and broader posterior sepal and a large horizontal landing—characters which favor humble-bees. The incurved spur measures about 6 mm. Humble-bees are more abundant and more constant in their visits than in I. fulva, while humming-birds were not seen visiting the flower.

Visitors: Hymenoptera—*Apidæ:* (1) *Bombus virginicus* Oliv. ♀, s. and c. p., ab.; (2) *B. americanorum* F. ♂, s. ab.; (3) *Megachile brevis* Say ♀, c. p., behaves as with I. fulva. *Andrenidæ:* (4) Halictus sp., s., not touching anthers and stigmas.

Diptera—*Syrphidæ:* (5) *Rhingia nasica* Say, s. and f. p.,

[9] Mutilation or perforation of the flowers of this species was recorded by Bailey: Torrey Bull. vi. 173; Trelease: ibid vii. 20; Van Ingen: Bot. Gaz. xii. 229.

not touching anthers when sucking. Several species of Syrphidæ eat pollen which is scattered on landing. Only nos. 1 and 2 are useful visitors.

Staphylea trifolia L.—Prof. W. J. Beal[10] examined the flowers of this plant and concluded "that the chances are better for cross-fertilization than otherwise." But Mr. Meehan[11] has interpreted it as adapted to self-fertilization. On the other hand, Dr. Gray[12] held that the flower is proterogynous and cross-fertilized by bees, and my observations led me to the same conclusion, while still unaware of his view. I find from Prof. Trelease's notes that he too regarded the flower as proterogynous. Newly opened flowers show a broad, three-lobed stigma nearly closing the entrance, and the still indehiscent anthers crowded under it. The surface of the stigma is always in advance of the anthers, and can hardly become thoroughly dusted with their pollen, even if it can receive enough for self-fertilization. The most that can be said is that the flower is self-fertilized in absence of insects—a very different thing from saying that it is adapted to self-fertilization. But the small number of fruit compared with the number of flowers leads me to doubt whether self-fertilization occurs, even when insects fail. Nectar is secreted by the disk surrounding the base of the ovary. The pendulous flower is about 6 mm. deep and the sepals and petals are erect and closely approximated, so that the flower has much the same form as in the gamopetalous genus Gaylussacia and has a like effect in excluding insects, although the petals are more yielding. The ovary, filaments and petals within are very hairy, and this also aids in making the honey less accessible to short tongues and in excluding small intruders. The flower thus favors long-tongued bees, although shorter-tongued insects sometimes succeed in forcing their way into the flowers far enough to reach the nectar.

Visitors (observed in five days, between April 23 and May 11): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ♀, s. c. p., ab.; (2) *Bombus virginicus* Oliv. ♀; (3) *B. vagans* Sm. ♀; (4) *B. americanorum* F. ♀—all 3 s., ab. *Andrenidæ:* (5–8) Andrena spp. ♂ ♀, s. and c. p., ab.; (9) Halictus sp. ♀, s.; (10) *H. coriaceus* Sm. ♀, s.; (11) *Colletes inæqualis* Say ♂, s. *Vespidæ:* (12) *Vespa maculata* L. s.

[10] Am. Naturalist i. 258.
[11] Proc. Acad. Nat. Sci. Phila., 1876, 108.
[12] See Just's Bot. Jahresbericht iv. 939.

Diptera—*Empidæ:* (13) Empis sp., s. *Syrphidæ:* (14) *Eristalis flavipes* Walk., f. p.

Lepidoptera—*Rhopalocera:* (15) *Nisonides juvenalis* F. s.

Coleoptera—*Scarabacidæ:* (16) *Euphoria sepulchralis* F. f. p.

Ceanothus Americanus L.—The flowers and their pedicels are white. The stems are surmounted by many umbel-like clusters of flowers, and many stems are crowded together; so that insects are attracted for a considerable distance by what seems one large bunch of white flowers. Each hood of a petal encloses an anther, and the petal and stamen rise together. The peculiar form of the petals is associated with a peculiar disposition of the sepals, which serve to conceal the nectar, so as to limit the visitors to a more diligent set than would predominate if the nectar were more freely exposed. The nectar is secreted on a broad disk which is concealed by the sepals remaining strongly closed over it. A petal and an anther have thus to be liberated through the narrow slit between two sepals, and the form of the blade of the petal is to allow it to escape and to free the anther with it. In character of visitors the plant resembles those Umbelliferæ in which the disk is covered by the incurved petals.

Visitors (observed on five days between June 19 and 29): Hymenoptera—*Apidæ:* (1) *Bombus separatus* Cr. ♀, s. and c. p.; (2) *B. pennsylvanicus* DeG. ♀, c. p.; (3) *Ceratina dupla* Say ♂, s.; (4) *Megachile brevis* Say ♀, s. and c. p.; (5) *Heriades carinatum* Cr. ♀, s. and c. p.; (6) *Nomada incerta* Cr. ♀, s.; (7) *Calliopsis andreniformis* Sm. ♂, s. *Andrenidæ:* (8) Macropis sp. ♂, s.; (9) *Augochlora pura* Say ♀, s. and c. p.; (10) *Halictus pectoralis* Sm. ♀, s. and c. p.; (11) *H. similis* Sm. ♀, s. and c. p.; (12) *H. flavipes* F. ♀, s. and c. p.; (13) *H. confusus* Sm. ♀, s. and c. p.; (14) *H. stultus* Cr. ♀, s. and c p.; (15) *Sphecodes confertus* Say ? ♂ ♀ s.; (16) *Prosopis affinis* Sm. ♂ ♀, s.; (17) *P. pygmæa* Cr. ♂ ♀, s. *Vespidæ:* (18) *Polistes pallipes* St. Farg. *Eumenidæ:* (19) *Eumenes fraternus* Say; (20) *Odynerus tigris* Sauss.; (21) *O. fulvipes* Sauss.; (22) *O. dorsalis* F.; (23) *O. foraminatus* Sauss.; (24) *O. conformis* Sauss.; (25) *O. pedestris* Sauss.; (26) *O. pennsylvanicus* Sauss. *Crabronidæ:* (27) *Crabro interruptus* St. Farg.; (28) *Oxybelus 4-notatus* Say; (29) *O. frontalis* Rob.; (30) *O. emarginatus* Say. *Philanthidæ:* (31, 32) Cerceris spp.; (33) *C. clypeata* Dahlb.; (34) *C. compacta* Cr.: (35) *C. compar* Cr.; (36) *C. rufinoda* Cr.

Larridæ: (37) *Larra acuta* Patton. *Sphecidæ:* (38) *Ammophila intercepta* St. Farg.; (39) *Pelopœus cementarius* Dru.: (40) *Isodontia philadelphica* St. Farg. *Pompilidæ:* (41, 42) Pompilus spp.: (43) *P. tenebrosus* Cr.: (44) *P. marginatus* Say; (45) *P. navus* Cr. *Chrysididæ:* (46) *Hedychrum violaceum* Brullé. *Chalcididæ:* (47) *Leucospis affinis* Say. *Tenthredinidæ:* (48) Atomacera sp.—all s. except no. 2.

Diptera—*Chironomidæ:* (49) Ceratopogon sp., f. p. *Mycetophilidæ:* (50) Sciara sp. *Culicidæ:* (51) sp. *Stratiomyidæ:* (52) Pachygaster sp. *Empidæ:* (53) Empis sp. *Syrphidæ:* (54) *Paragus bicolor* F.; (55) *Chrysogaster nitida* Wied.; (56) *Syrphus americanus* Wied.; (57) *Allograpta obliqua* Say; (58) *Mesograpta geminata* Say; (59) *M. marginata* Say; (60) *Sphœrophoria cylindrica* Say; (61) *Tropidia mamillata* Lw.; (62) *T. quadrata* Say; (63) *Syritta pipiens* L. *Conopidæ:* (64) *Conops brachyrrhynchus* Macq.; (65) *Zodion fulvifrons* Say; (66) *Oncomyia loraria* Lw. *Tachinidæ:* (67, 68) spp.; (69) Hyalomyia sp.; (70) *Cistogaster divisa* Lw.; (71, 72) Ocyptera spp.: (73) *Jurinia smaragdina* Macq.; (74) *J. apicifera* Walk.; (75) *Cyphocera ruficanda v. d.* Wulp.; (76) Micropalpus sp.; (77) Exorista sp.; (78) Eggeria? sp.; (79) *Acroglossa hesperidarum* Will? *Sarcophagidæ:* (80, 81) Sarcophaga spp. Muscidæ: (82) sp.; (83) *Musca domestica* L.; (84) Lucilia, sp.; (85) *L. cæsar* L.; (86) *L. cornicina* F. *Anthomyidæ:* (87) Anthomyia sp.; (88) Limnophora sp. *Trypetidæ:* (89) *Trypeta humilis* Lw? *Sepsidæ:* (90) Sepsis sp. *Oscinidæ:* (91, 92) spp.; (93) Oscinis sp.—all s. or f. p.

Coleoptera—*Dermestidæ:* (94) *Cryptorhopalum hæmorrhoidale* Lec. *Elateridæ:* (95) *Limonius griseus* Beauv. *Lampyridæ:* (96) *Telephorus scitulus* Say. *Scarabæidæ:* (97) *Trichius piger* F. *Cerambycidæ:* (98) *Typocerus sinuatus* Newm. *Chrysomelidæ:* (99) *Pachybrachys atomarius* Melsh.; (100) *Diabrotica 12-punctata* F.; (101) *D. atripennis* Say. *Œdemeridæ:* (102) *Oxacis thoracica* F. *Mordellidæ:* (103) *Mordella marginata* Melsh. *Curculionidæ:* (104) Centrinus sp.; (105) *C. scutellum album* Say; (106) *C. picumnus* Hbst.

Hemiptera—*Capsidæ:* (107) *Calocoris rapidus* Say; (108) *Lygus pratensis* L. *Lygæidæ:* (109) *Lygæus turcicus* F. *Cydnidæ:* (110) *Canthophorus cinctus* P. B.—all s.

Lepidoptera—*Rhopalocera:* (111) *Thecla acadica* Edw.; (112) *T. calanus* Hübn.

Carlinville, Ill.

The station botanists at Washington.

The establishment of the experiment stations under the so-called "Hatch Act" has brought many botanists into lines of work that may run parallel in some respects, and therefore furnished the occasion for a union among these workers. Several of the station botanists were in attendance at the A. A. A. S. meeting at Toronto in August last, and one afternoon they found time to hold a meeting, with Dr. W. J. Beal in the chair, in which several station matters were considered. For example, the limitations for the several classes of station workers were discussed, and more particularly the topic: "What is the botanist's work in the station?" There are lines of work, as for instance the cross-fertilization of plants, that come quite naturally to either the skilled agriculturist, horticulturist or botanist, and must be decided by the circumstances of each particular case. The character of the station bulletin was considered, and the opinion generally prevailed that it should be founded upon observations and experiments made by the author, but should not exclude valuable matter elsewhere to be obtained. It was the sentiment of the meeting that collections should be made and exchanges encouraged, especially of specimens of plants most frequently referred to by station botanists. It was considered important that the station workers should meet at least once each year for conference, consultation, etc., and a committee was appointed to communicate with the director of the office of experiment stations upon this subject.

The following suggestions were sent by the committee:

"*Sir:* The undersigned have been appointed, at a meeting of the botanists of the experiment stations, a committee to call your attention to the desirability of urging upon officers of the stations that they send to the coming annual meeting of the association of colleges and experiment stations representatives of their working corps. We further wish to suggest that, in our opinion, such a gathering of the station workers would result in great good and that the stations might well defray all necessary expenses. May we not suggest that you urge this matter upon station officers?

"CHARLES E. BESSEY,
"S. T. MAYNARD,
"T. J. BURRILL,
"*Committee.*"

The following botanists were present: J. C. Arthur, W. J. Beal, C. E. Bessey, T. J. Burrill, F. V. Coville, B. E. Fernow, W. R. Lazenby, S. T. Maynard, Wm. Saunders, F. L. Scribner, B. M. Waite, C. E. Weed and the secretary, B. D. Halsted.

The Washington meeting of the Association of A. A. C. & E. S. was held on November 12–15, and several botanists were in attendance. Nothing of a botanical nature was provided for in the printed program of the convention, and there were objections raised as to the desirability of the association dividing into sections for special work, and it was not until near the close of the sessions that any provision was made for the holding of meetings of specialists. It was finally adopted that the association shall be divided into at least five committees as follows: Agriculture, Botany, Chemistry, Entomology and Horticulture. Previous to this, however, the botanists had held two meetings, making three in all. Several of the older botanists of the experiment stations, as, for example, the three B's, were unavoidably absent, the meeting coming at an unusually busy time of year.

Dr. Geo. Vasey was called to the chair and presided over the first two sessions of the botanists. After some routine work, the chairman presented a valuable paper upon the growth and future hopes of the Division of Botany of the U. S. Department of Agriculture. From a very small beginning, less than a quarter of a century ago, this division of the government service has increased in value and efficiency until now it is recognized as a great botanical center in our country, and especially so by the botanists of the experiment stations. Dr. Vasey called attention to the great need of works upon botany suitable to the territories and newer states, and stated that a small increase of his force would render it possible to supply the demand—a demand that is not likely to be met by private enterprise for a long time to come. A generous invitation was extended to the station botanists to avail themselves of the large opportunities for study offered by the Division of Botany.

After an interesting discussion upon topics suggested by Dr. Vasey's paper a committee was appointed to consider the relationship that exists between the Division of Botany and the station botanists, which committee drew up the following:

"The station botanists desire to express their hearty appreciation of the generous support afforded the Botanical

Division of the Department of Agriculture as is evidenced by the printing of the various bulletins of the division and the publication of a journal devoted to the special interests of botanists, and in view of the unequalled facilities afforded by the large amount of botanical material accumulated in the division available for the preparation of much needed monographs of important or difficult groups of plants, wish to urge upon the attention of the Secretary of Agriculture the desirability of prosecuting this special work and its early publication, both in the interest of botanical science and for the direct assistance of station botanists."—F. L. Scribner, S. M. Tracy and B. D. Halsted, committee. Professors Tracy, Coulter, Scribner and others urged the importance of both making the fullest use of the division and aiding in increasing its collections and usefulness.

A paper by Dr. Beal was next read by the secretary upon "The Province of the Botanist in the Experiment Station." The stations are new, and widely different views prevail as to the work a botanist should do. Some think the botanist, for example, should study the life-histories of parasitic fungi, but the testing of remedies belongs to the horticulturist. Others consider that the study of bacteria is most closely related to the work of the veterinarian. If the agriculturist is not able to distinguish among grasses in his experimental plots he should call in the assistance of the botanist. The botanist should cross or hybridize plants, improve grasses and other crops, and test remedies for fungus diseases. But above all, the staff of any station should work harmoniously, and this requires that plans of experiments should be submitted in detail to the whole station staff.

Dr. Coulter thought there was one of two things for the station authorities to do in securing a botanist: (1) If they know what they want done, then a man should be obtained that is a specialist in that work; or (2) if they do not, the wise way is to get a competent botanist and then let him select his work.

The question was raised: Should station botanists teach? There was a difference of opinion. Dr. Arthur, of Indiana, has a few of the more advanced botanical students in his laboratory, but the elementary instruction is done by a university professor who is not on the station staff. A paper from Dr. Bessey was closely related to the point under discussion and was read at this time. It favored the close connection of the station and the university for various reasons, but chiefly

because this arrangement was mutually helpful. Students when advanced can do some of the station work, under guidance, and thus increase the mass of facts desired by the station, while at the same time learning how to investigate. Dr. Bessey has been able to obtain much good work for bulletins in this way. The opinion prevailed that the station worker should not be burdened with large elementary classes, but a few advanced laboratory students are an advantage, especially if there are no regular assistants.

A paper was next presented by Prof. McCarthy upon seed-testing, giving results of extended experiments in this direction, accompanied by an explanation of a seed-testing pan placed on exhibition. Prof. Chester reported upon tests of seeds he had made, and was convinced that this line of work had been much neglected. Good-looking sorghum seed, for example, proved worthless, and much of the tested grass seed contained only twenty-five per cent. of good seed. Professor Scribner thought that seed-testing in itself was not proper work for the station botanist. Dr. Arthur stated that in his opinion we do not need seed-control stations in this country. Prof. McCarthy offered the following resolution: "That the chair appoint a committee of three to consider and recommend a uniform method of testing seeds and recording results." Professors Arthur, McCarthy and Chester constitute said committee, to report at the next annual meeting.

The balance of the time was occupied in individual reports of work done during the past year. Professor Galloway presented a report of the advances made in his section of vegetable pathology:

The work of the section is divided into two branches, namely: laboratory investigations and field experiments. After a subject is investigated in the laboratory, special agents in different parts of the country are selected to conduct experiments in treatment, these to be based upon the result of the laboratory work. During the present season agents have conducted field work in New Jersey, Virginia, Maryland, South Carolina, Georgia, Mississippi, Arkansas, Missouri, Wisconsin, Michigan, California; and the principal maladies under treatment were black-rot, downy mildew and anthracnose of the grape; powdery mildew, scab, rust and bitter-rot of the apple; potato-blight and rot; pear leaf-blight; quince leaf-blight; and strawberry leaf-blight, or rust, as it is more commonly called. Concerning black-rot, the result of the season's work has shown that the Bordeaux

mixture, containing from six to eight pounds of copper sulphate and from four to six pounds of lime, is the most reliable remedy. The ammoniacal carbonate of copper solution, however, promises to be fully as valuable as the last. It, moreover, is cheaper and can be applied with any ordinary nozzle. Downy mildew can easily be controlled by any of the copper remedies, the ammoniacal solution being the best under all circumstances. The experiments showed that anthracnose will develop despite the application of copper remedies. Powdery mildew of the apple has been treated with excellent results, the preparation used for this purpose being the ammoniacal carbonate solution. This experiment was carried on under Prof. Galloway's own supervision at nurseries near Baltimore, 300,000 apple seedlings being treated. Treatment of pear leaf-blight (Entomosporium) was made in the same nurseries, also in New Jersey, the results being highly satisfactory. The experiments in the treatment of apple scab were conducted by Professors Goff, of Wisconsin, and Taft, of Michigan. Early in the spring a plan of the work was drawn up and sent to both these men. Both carried on practically the same, but entirely independent, experiments, and both arrived at the same results, namely, that the scab could be controlled by any of the fungicides used; but all things considered the ammoniacal carbonate of copper solution was the cheapest, most practical and efficacious.

Other botanists spoke of their work very briefly, but the lateness of the hour made it necessary to bring the exercises to a summary close. It was voted that during the coming year a station botanists' bulletin be prepared, in which each botanist should outline the work already done or in progress, and thus facilitate coöperation whenever it is desired. Professors Halsted, Scribner and Galloway were made such a committee, after which the Botanical Committee of the Association of American Agricultural Colleges and Experiment Stations (a long name, by the way), with Professor S. M. Tracy in the chair, adjourned.

BYRON D. HALSTED, *Secretary*.

The relation of the flora to the geological formations in Lincoln county, Kentucky.

HARRY A. EVANS.

All farmers recognize the relation existing between the timber and the soil (which must result in most cases from the underlying rock), as is evident from the expressions which they use in speaking of the quality of land, such as "walnut land," "white oak land," "beech land" and "ash land," as Henry Clay called his place from the abundance of ash trees which grew upon it. This relation is constantly forced on the collector's notice, and especially is this the case where the territory collected over has a number of formations represented. In this (Lincoln) county there are some twenty formations, all but two of which are of such surface extent as to give rise to characteristic soils.

Last summer I made as complete a list as was possible of the flowering plants occuring on each of these formations, taking care to include no plant which seemed to owe its position to the elevation or moisture of any formation, rather than to the character of the soil. Similar formations in the surrounding counties were examined, and the list corrected by dropping the names of any plants which were not common to each horizon in all of its exposures. (In the case of the Chazy, Birdseye and Upper Subcarboniferous this was not done.)

From this list, thus corrected, I have tried to determine the species which prefer, or are peculiar to, each of the formations in this county. Whether the results, as given in this article, will hold good for other localities I do not know; if they do not it will show that the position of the plants here is due to some condition of exposure, elevation or moisture, and not to the character of the soil. I hope that collectors in states where the formations here given occur will test the results.

Most of the plants which are mentioned on only one formation I have never found on any other; with one exception no plant is mentioned if only a small number of specimens of it have been observed.

CHAZY.—The Chazy limestones, 225 feet in thickness, are seen in this state only on the Kentucky and Dix rivers, near the mouth of the latter. They form the base of the high

cliffs through which these streams flow at that point, and are the oldest rocks brought to view in the state. They give rise to no soil; the plants mentioned as occurring on them are found growing in crevices in the cliffs.

Silene rotundifolia Nutt.
Polygala Senega L.
Cladrastis tinctoria Raf.
Ribes Cynosbati L.
Galium trifidum L.
G. circæzans Michx.
Nemophila microcalyx Fisch. and Meyer.
Enslenia albida Nutt.
Ulmus racemosa Thomas.
Tradescantia pilosa Lehm.

Birdseye.—The Birdseye is found just above the Chazy, and like it is seen only at and near the mouth of Dix river. It forms no soil; the plants mentioned are found in fissures in the rock.

Arenaria patula Michx.
Polygala Senega L.
Galium trifidum L.
Juniperus Virginiana L. Covering the cliff wherever it can get a foothold.

Trenton.—There are four phases or divisions of the Trenton in this section: (1) at the base a siliceous clay; (2) beds of gray and dark blue limestones—the Blue Grass Beds: (3) a granular limestone, frequently nearly a sandstone; and (4) dove-colored limestones, much like the Birdseye. All of the series form excellent soils, the Blue Grass limestones giving the best in the state—the famed Blue Grass soils.

(Siliceous limestone.)

Liriodendron Tulipifera L.
Silene noctiflora L.
Hydrangea arborescens L.
Quercus alba L.
Fagus ferruginea Ait.
Stylophorum diphyllum Nutt.
Tilia Americana L.
Acer saccharinum Wang.
Gymnocladus Canadensis Lam.
Prunus serotina Ehrhart.
Geum macrophyllum Willd.
Fraxinus quadrangulata Michx.
Ulmus Americana L.
Celtis occidentalis L.
Morus rubra L
Carya sulcata Nutt.
Polygonum biflorum Ell.
Quercus Prinus L.

(Granular Limestone.—Entirely barren at the only place I have seen it in this county.)

(Upper Birdseye.)

Juniperus Virginiana L.

Lower Hudson River.—These beds are made up of alternate layers of limestones and shales; where exposed the

latter decompose very rapidly, giving rise to an excellent soil.

Euonymus atropurpureus Jacq.
Quercus alba L.
Q. obtusiloba Michx.
Q. imbricaria Michx.
Trillium grandiflorum Salisb.

MIDDLE HUDSON RIVER.—Composed of sandy shales and sandstones, which give rise to a soil that remains moist in the driest weather.

Liriodendron Tulipifera L.
Oxalis violacea L.
Cuphea viscosissima Jacq.
Asclepias incarnata L.
Polygonum Virginianum L.
P. dumetorum L.
Euphorbia humistrata Engelm.
E. commutata Engelm.
Fagus ferruginea Ait.
Trillium grandiflorum Salisb.

UPPER HUDSON RIVER.—These beds fall naturally into three divisions; at the base (1) a limestone (full of fossils) in thin layers, between which are layers of clay shales; this division decomposes rapidly, forming an excellent soil; (2) sandy limestones, in beds of considerable thickness; and (3) a limestone containing much earthy matter and silica.

(1. Lower Division.)

Anemone Caroliniana Walt.
Ranunculus muricatus L.
Aquilegia Canadensis L.
Dicentra cucullaria DC.
D. Canadensis DC.
Corydalis flavula Raf.
Dentaria multifida Muhl.
Silene Virginica L.
Lychnis Githago L.
Prunus serotina Ehrhart.
Eupatorium ageratoides L.
Aster oblongifolius Nutt.
Collinsia verna Nutt.
Fraxinus quadrangulata Michx.
Celtis occidentalis L.
Juglans cinerea L.
Quercus alba L.
Q. Prinus L. var. acuminata Michx.
Trillium sessile L.

(2. Middle Division.)

Impatiens pallida Nutt.
I. fulva Nutt.
Trifolium procumbens L.
Œnothera biennis L.
Galium Aparine L.
Asclepias Cornuti Decaisne.

(3. Upper Division.)

Galium triflorum Michx.
Eupatorium serotinum Michx.
Scrophularia nodosa L.
Asclepias tuberosa L.
Pilea pumila Gray.
Pardanthus Chinensis Ker.

MEDINA.—Soft, easily pulverized, giving a sandy soil which erodes badly, and which once denuded of vegetation rarely becomes covered again.

Sassafras officinale Nees.
Quercus alba L.
Q. obtusiloba Michx.
Q. falcata Michx.

CRAB ORCHARD SHALES.—Mud shales, containing a few thin layers of limestone.

Acer rubrum L.
Negundo aceroides Moench.
Gleditschia triacanthos L.
Liquidambar Styraciflua L.
Ulmus Americana L.
Platanus occidentalis L.
Juglans nigra L.
Carya alba Nutt.
Quercus alba L.
Q. obtusiloba Michx.
Q. macrocarpa Michx.
Q. Prinus L. var. acuminata Michx.
Q. rubra L.

CORNIFEROUS.—Layers of limestone, often containing masses of silica, forming a red soil.

Hypericum perforatum L.
Acer saccharinum Wang.
Cassia Marilandica L.
C. Chamæcrista L.
Potentilla paradoxa Nutt.
Vernonia Noveboracensis Willd.
Lobelia leptostachys A. DC.
L. spicata, Lam.
Acalypha Virginica L.

BLACK SLATE.—Thin layers of slate which are somewhat bituminous. When well-drained this slate decomposes into a soil which is fair, especially where there is a leaf-mold. In places where the layers of slate are horizontal the drainage is poor, giving rise to a very wet soil.

(Level and badly drained portion.)

Polygala Curtissii Gray.
Rhexia Virginica L.
Quercus alba L.
Q. obtusiloba Michx.
Q. imbricaria Michx.
Q. rubra L.
Commelyna Cayennensis Richard.

(Well-drained portion.)

Liriodendron Tulipifera L.
Rhus glabra L.
Desmodium Dillenii Darlingt.
Lespedeza repens Torr. & Gray.
Liquidambar Styraciflua L.
Vernonia Noveboracensis Willd.
Gerardia integrifolia Gray.

LOWER SUBCARBONIFEROUS.—This formation has at its base (1) a considerable thickness of ash colored shales; (2) above these harder shales with some limestones; (3) just above the upper subcarboniferous, hard shales and sandstones.

(Lower Division.)

Ascyrum Crux-Andreæ L.
Stylosanthes elatior Swartz.
Eupatorium purpureum L.
Aster longifolius Lam.
Polymnia Uvedalia L.

(Middle and Upper Divisions.)

Eupatorium sessilifolium L.	Euphorbia corollata L.
E. perfoliatum L.	Castanea vesca L.
Oxydendrum arboreum DC.	Pinus mitis Michx.
Kalmia latifolia L.	

Upper Subcarboniferous.—Heavy beds of limestones, found only on the highest knobs.

Hypericum nudicaule Walt.	Q. coccinea Wang.
Quercus nigra L.	Juniperus Virginiana L.

The Birdseye and Upper Birdseye, both pure limestones, are covered by cedars, to the exclusion of nearly everything else. On the Upper Subcarboniferous limestones cedar is present in large numbers, but does not attain such size as on the other formations; at every point at which I examined the Upper Subcarboniferous, if not covered with cedar, *Hypericum nudicaule* Walter is found in the greatest abundance.

The Oaks are represented by some species on most of the formations. *Quercus alba* L. is found in numbers on the Lower and Upper Hudson River Beds, and on the Medina sandstone, but seems to prefer the siliceous limestones at the base of the Trenton. *Q. obtusiloba* Michx. is found on all formations which give rise to a light or sandy soil. Excepting a few small trees on the Black Slate, *Q. imbricaria* Michx. is found only on the Lower Hudson River. So far as can be determined from observations in this county, *Q. nigra* L. and *Q. coccinea* Wang. are characteristic of the Upper Subcarboniferous.

Fagus ferruginea Ait. prefers a siliceous soil; and in Lincoln is most abundant on the siliceous limestones of the Trenton, but in the surrounding counties the beech forests are on the Middle Hudson River Beds—the "siliceous mudstones" of the old Kentucky reports.

Stanford, Ky.

EDITORIAL.

The Gazette is naturally deeply interested in the success of the Agricultural Experiment Stations, because the establishing act makes such extensive provision for botanical investigation. It is because of our great interest in their work that we have ventured to express our opinion as to its direction and scope, and particularly as to the mode of presentation. It seems that some of the experiment stations think our advice

unwise—which is not surprising. It will consequently not be amiss to make our position clear.

It is certainly true that two main lines of botanical work were contemplated for the stations. One important feature is to be *original research;* the other, of equal importance, is the *diffusion* of knowledge among the practical gardeners, florists, nurserymen and farmers. The latter end may be accomplished by the publication of résumés of knowledge in particular lines. In the selection of the topics, good judgment is essential, if the publications are to meet with the favor of those who are to be benefited. Undoubtedly there are thousands of facts already known to physiologists which would be of interest and advantage to agriculturists to know. Once this is adequately done for any one subject the field will open for the carrying out of the original research which is contemplated. For no one can make a thorough study of a subject without finding out directions in which knowledge can be advanced. How many suggestions will be received and how fruitful in original work these will be will depend altogether upon the acuteness and skill of the individual. If our position so far is correct, it will be seen to necessitate the study of botanical literature, a point which we have insisted upon so often that it would be tiresome to say more.

But we must strongly insist that common honesty demands the separation of bulletins of information from bulletins of research. The latter, however, to be complete, must contain a statement of the previous knowledge, and these parts must be distinctly credited to their sources. It is hardly fair to conduct a series of experiments on ground that has already been covered by some foreign investigation and then to publish these as though the matter was new and the ideas originated with the last experimenter. But, it is urged, though the experiments have been conducted in another country, they are of little value because the plants and conditions are not identical with those of this country. Granted, for the sake of the argument; does it follow that when the experimenter publishes his results he should omit to state that the ground has already been traversed under such and such conditions, and to point out wherein the later experiments differ from the earlier ones? And if the experiments give the *same results* and point to the *same conclusions*, of what possible use is it to waste space and time in publishing the details?

If this publication of unimportant details continues with no reference to earlier literature, it will deepen the reproach of American botanical work, and will confirm the neglect with which it has to contend. Further, such work is open to the suspicion, whether true or not, that the failure to give due credit to other observers is prompted by a desire for the glory which of right belongs to others.

CURRENT LITERATURE.

Minor Notices.

MR. H. L. RUSSELL conducted a series of experiments in the winter of 1888–'89 to determine the character of bacteria in the ice of Lake Mendota, at Madison, Wis. From his paper[1] we learn that no pathological germs were present; that the freezing destroys about sixty per cent. as compared with the number found in the water; and that no relation exists between the number of germs in clear ice and snow-ice, in some cases a larger number being found in clear transparent ice than was found in any sample of snow-ice. The experiments are to be continued this winter.

MR. TH. HOLM describes[2] the mode of propagation of Hydrocotyle Americana by tuberiferous stolons, and gives an account of their structure, with references to the descriptive works where this mode of propagation is either not noticed or barely hinted at. Curiously, however, he fails to notice that in Coulter and Rose's Revision of the Umbelliferæ the occurrence of these tubers is made a specific character. The plates which accompany his paper are excellent. We hope he will carry out his intention of recording more such "notes."

IN THE *Proc. Boston Soc. Nat. Hist.* for 1889, Mr. A. B. Seymour prints a list of the fungi which he collected along the line of the N. P. R. R. at various points in 1884. One new species is described, Uromyces Alopecuri, on Alopecurus geniculatus, var. aristatus at Brainerd, Minn., and one new variety, Sorosporium Ellisii, var. occidentalis, on Andropogon furcatus at Bismarck, Dak.

NOTES AND NEWS.

DR. J. H. WAKKER, of Utrecht, has been appointed professor of botany at the dairy school at Oudshoorn, Holland.

DR. F. NOLL, assistant at Würzburg under Prof. Sachs, has been called to a professorship of botany at the University of Bonn.

DR. G. VON LAGERHEIM, attaché of the botanical laboratory of the University of Lisbon, has been called to the professorship of botany in the University of Quito.

THE GREAT book establishment of F. A. Brockhaus, in Leipzig, has issued its 1889 catalogue of second-hand botanical works. It is a classified list of over 3,400 titles, issued in four parts, which will be sent free upon request.

[1] Preliminary observations on the bacteria of ice from Lake Mendota, Madison, Wis. Reprinted from *Medical News*, August 17, 1889. Repaged. pp. 15.

[2] Notes on Hydrocotyle Americana.—Extracted from Proc. Nat. Museum, xi. pp. 455–462, pl. xvi and xvii.

A. MUNTZ states (*Comptes Rendus*, cix. 646), as the result of a series of experiments, that the higher plants can absorb ammoniacal nitrogen directly by their roots, and that the nitrification of ammoniacal manures is not an indispensable condition to their utilization.

WHEREAS THE seedlings of most Conifers produce chlorophyll, even when grown in the dark, Molisch has recently shown that those of Gingko biloba show only traces of it under such conditions. Thus the etiolation which is exceptional among the larches, firs and pines becomes normal in the Gingko.

A GIGANTIC fig tree is described and figured in *Gardeners' Chronicle* (Oct. 26). It grows in the garden of the old Capuchin Convent at Roscoff, N. W. France. It is 2½ feet in diameter, 3½ feet from the ground, and the spread of branches is 80 feet. The limbs are supported on stone and wooden pillars.

IN A RECENT NUMBER of *Science* Dr. Goodale's Toronto address upon "Protoplasm" was printed in full. As it was evidently set up from the pages of the GAZETTE a reference to that fact was looked for, but in vain. The occasional abstraction of a short note without credit is not seriously objected to, but the wholesale appropriation of a leading article is somewhat bewildering. Legal rights are not referred to, but common courtesy.

DZIEWULSKI has redetermined the specific gravity of wood fibers. Those of deciduous trees vary between 1.540 and 1.560; of coniferous trees, between 1.535 and 1.555. After complete removal of the resin, however, the latter become 1.560. Curiously enough, with few exceptions, the specific gravity of the fibers from the softer deciduous trees is higher than that of the hard woods. In general the results confirm those of Sachs and Hartig.

DR. HERMANN DINGLER has lately published an elaborate monograph on the movements of the winged organs of plants. He treats the mechanics of the free fall of such winged structures, determining the rate of fall in still air. In the more perfectly developed wings the rate is from 2 to 6.5 times slower than when the organ is deprived of its wings. He distinguishes twelve types of wings, using the word in such a broad way as to include the adhering layer of air, which by reason of their small size retards the fall of spores and small seeds. Of course these types have numerous intergradations.

AERENCHYMA is the name of a tissue homologous with cork, which Dr. H. Schenck describes in *Pringsheim's Jahrbücher*, xx. 526. It occurs in marsh plants on submerged parts of the stems, arising from the phellogen usually. The cells have thin walls (not suberized) and contain protoplasm, nucleus, a large vacuole with clear cell-sap, minute leucoplasts, in some cases starch grains, but never air. They are in contact with each other only in small areas, and therefore have very large intercellular spaces which are filled with air. As the tissue develops it ruptures the epidermis and primary contex, so that the intercellular system comes into communication with the exterior by numerous pores and rifts, into which, however, the water never penetrates. The air in these spaces contains a large percentage of oxygen (30 p. c. in Lythrum salicaria) and it is safe to conclude that this tissue aids in supplying oxygen for the respiratory needs of the submerged parts of plants. In some other plants the abundant development of lenticels on the submerged parts or the formation of aërotropic roots or of pneumatodes seems to subserve the same function.

SHORTIA has long been regarded as one of the rarest plants in the North American flora. Now, however, it is known to be so common, in at least one region, that a long established vernacular name for it is in common use among the few families of mountaineers who inhabit the valleys at the headwaters of the Savannah river, where Shortia is found. Galax, the near relative of Shortia, is known almost universally to the people of the southern Alleghany Mountains as Coltsfoot, from a fancied resemblance of the leaf to that of a colt's foot The smaller leaf of Shortia, which resembles somewhat the leaf of Galax, is called "Little Coltsfoot."—*Garden and Forest.*

NORTH AMERICAN ROSES furnish a subject for Dr. G. N. Best in the *Journal of the Trenton* (N. J.) *Natural Hist. Soc.* (Jan., 1889). He considers their classification, and well expresses its difficulty by his opening sentence: "To the botanist who yearns to enrich synonymy, the roses offer at once an inviting and productive field." He recounts the sending to Sir Joseph Smith by Amos Eaton of three specimens from the same bush, two of which were referred by that distinguished botanist to two described species, and the third described as a new species. With such facts can it be wondered at that "the study of roses is in its infancy"? It may be a serious question whether there are species among roses. Dr. Best appends a classification, which is a modification of M. Crèpin's.

BOKORNY finds (*Prings. Jahrbücher,* XX. 427) that the phenomenon of "aggregation," first described by Darwin as taking place in the cells of the tentacles of Drosera when treated with a very weak solution of ammonium carbonate, is quite widespread, occurring in phanerogams and algæ of the most diverse families. It can be produced by almost any substance of a basic nature. He distinguishes four modes of aggregation, (*a*) contraction of the entire plasma, (*b*) contraction and division of the vacuole wall or tonoplast, (*c*) the extrusion of minute droplets of proteids from the cell-sap and their fusion into larger masses, and (*d*) similar separation of the proteids of the plasma. These forms of aggregation do not usually occur singly in any cell, and probably depend on the transition of the proteids from a swollen condition to a denser, on account of a loss of water induced by the basic substance. As to the biological significance of the phenomenon, he ventures no opinion.

THE DEATH is announced of Mr. John Ball, the distinguished English botanist. His studies were devoted largely to botanical geography and to philosophical questions relating to the origin and descent of existing floras. Mr. Ball's best known works are "The origin of the Flora of the European Alps," published in 1878, and his "Contributions to the Flora of the Peruvian Andes, with remarks on the history and origin of the Andean Flora," published in 1885, in the journal of the Linnæan Society. He accompanied Sir Joseph Hooker, in 1871, in his scientific mission to Morocco, publishing on his return a catalogue of the plants discovered, with critical introductory observations (his first attempt to explore the chain of the Greater Atlas was made as early as 1851). Mr. Ball traveled extensively and was a practiced and accurate observer, and one of the very best books of recent travels is the one in which he described his South American journey, which carried him around that continent. Mr. Ball was in North America in 1884 at the meeting of the British Association at Montreal, and of the American Association at Philadelphia, later, accompanying his old friend and correspondent, Dr. Asa Gray, on the last journey the Cambridge professor made to Roan Mountain and other points of botanical interest in North Carolina. Mr. Ball belonged to a school of botanists of which only a few members remain; and he was almost the last of his associates and contemporaries.—*Garden and Forest.*

In an extensive paper on the chlorophyll-free humus plants and their biological and anatomical relations (*Prings. Jahrbücher*, xx. 475) Dr. Friedrich Johow gives first an account of the geographical distribution of the 43 phanerogamic genera and 162 species. They are essentially plants of the tropics, 121 species belonging to these regions, about 55 of these occurring in tropical America. One is found in antarctic America; about 25 in North America. After giving an account of the habitat, habit and gross anatomy, the anatomical peculiarities are discussed. Naturally the most aberrant organ is the root. On the roots of all holosaprophytes, with one exception, root-hairs are wanting. The cortex is strongly developed. The central cylinder differs from most roots in the altered grouping of the xylem and phloëm regions, the reduction of the vascular portion, or the incomplete differentiation of the procambium elements. The roots almost without exception are associated with a fungus, producing the mycorhiza of Frank. The epidermis of the shoot of all holosaprophytes, with the exception of Epipogum aphyllum, shows *no stomata*, and the cortical parenchyma has small intercellular spaces or none. The mechanical system of the stem is represented only by a simple sclerotic ring outside the vascular bundle. The paper closes with an account of the embryology of the various orders. In all the embryo of the very small seeds is extremely rudimentary. In one case the endosperm consists of three cells and the embryo of three!

The Western Society of Naturalists held its second annual meeting at Madison, Wisconsin, October 23 and 24. There were fewer in attendance than at the first meeting, but the sessions were of marked interest. The botanical papers presented were as follows: J. C. Arthur, Laboratory facilities for the study of physiology; C. E. Bessey, What to do with a beginner in botany; E. A. Birge, Elementary bacteriology in general college courses; C. R. Barnes, Recent methods in embryology and histology. The President's address was delivered on Wednesday evening on the topic, The method of multiple working hypotheses in investigation, instruction and citizenship. After the address an exhibition of the powers and adaptability of the Wright & Newton electric microscope for the projection of microscopic sections of rocks, minerals, plants and animals was given in the geological lecture room. A section of the fibro-vascular bundle of the pumpkin was shown under a magnification of about 10,000 diameters, the large pitted vessels appearing about three feet in diameter. Nuclei of the root tip of the bean were shown three inches in diameter. The constitution was amended so as to bring the annual meeting hereafter in November, instead of October. Purdue University, La Fayette, Indiana, was selected as the next place of meeting, with Dr. C. E. Bessey as president, and Dr. J. S. Kingsley as secretary. The afternoon of Thursday was devoted by members to the inspection of the laboratories and museums of the University.

Dr. Adam Prazmowski summarizes in the *Biologisches Centralblatt* (ix, 417) his recent results in the study of the root tubercles of the Leguminosæ. The chief points may be stated thus: The tubercles are not normal structures but are due to the infection of the very young rootlets with bacteria. These bacteria may be obtained in pure cultures from the young roots and may be cultivated in nutritive solutions to thousands of generations. They show no diminution of their power under such cultivation. If the root is not infected when very young it remains to the end of its life free from the tubercles. The bacteria penetrate the cell wall of the root hairs and epidermis, and multiply therein

at the cost of their contents. When they have multiplied to large numbers in the root hair they accumulate near the apex of the hair as a tubular conglomerate of colonies which surround themselves with a thick membrane. After a time of development this structure grows toward the base of the root hair like a hypha-tube, and from this time on behaves like a true hyphal fungus. The tube has the thick, refractive membrane on the outside, and is densely filled with bacteria inside. It penetrates to the interior of the rootlet and induces the abnormal development of certain tissues, resulting in the formation of a tubercle. After the tissues of the tubercle have differentiated part of the tubes are dissolved and the bacteria set free, while part remain. The free bacteria multiply freely and take on a somewhat different form (forked) when they constitute the well-known "bacteroids." As to the rôle of the bacteria in the life of the plant, the author agrees with Hellriegel, that they enable the plant to obtain nitrogen, but whether this is taken in the form of compounds or from the free nitrogen of the air, he is not prepared to say. The remaining life history of the bacteria has also been worked out by the author, but we can not go further into details. The summary is a most interesting contribution to this important controversy.

IT IS STARTLING to compare a past in which botany was regarded as a subject which might be tacked on anywhere, with its present condition, in which there is scarcely a seat of learning in the three kingdoms which is not turning out serious work. But it would be a mistake to suppose that English modern botany has developed a character of its own in which the indirect influence of Darwin's later work can be not indistinctly traced. Darwin by his researches on insectivorous plants and plant movements from a purely biological point of view, prepared the way for this. Gardiner followed with a masterly demonstration of the physical continuity of protoplasm in plant tissues. Mr. F. Darwin has started what is virtually a new conception of the process of growth. On the whole, English botanists have shown a marked disposition to see in the study of protoplasm the real key to the interpretation of the phenomena of plant life. The complete analogy between the processes of secretion in animals and vegetables, established by Gardiner, and the essential part played by ferments in vegetable nutrition, illustrated by Green, are examples of the results of this line of inquiry.—*Nature.*

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